

AMENDMENTS TO THE SPECIFICATION

Please replace paragraph [0003] of the current specification as follows:

[0003] Some amount of residual toner remains on the photosensitive member after image transfer and requires removal, such as by bringing a cleaning blade or other scraping mechanism into contact with the photosensitive member. The waste toner thus removed oftentimes is collected within a container included in the image forming apparatus. Potentially significant amounts of waste toner may be collected over time, particularly in machines that include multiple process cartridges, each of which acts as a source of waste toner.

Please replace paragraph [0012] of the current specification as follows:

[0012] Regardless of its specific implementation details, image forming apparatus 10 uses a consumable developer material, such as particulate toner, to form desired images on media sheets processed by it. Thus, image forming apparatus 10 may be a “laser” printer, copier, facsimile, etc. During imaging operations, image forming apparatus 10 forms desired images, e.g., text, graphics, etc., by transferring developer from one or more image transfer members, such as rotating photoconductive drums, to copy sheets or other media being fed through the image forming apparatus 10. Residual developer material is scoured or otherwise cleaned from the image transfer members between image forming operations to maintain the requisite print quality. This residual developer material, which broadly is referred to as “waste toner” herein, is collected within image forming apparatus 10 in a controlled fashion.

Please replace paragraph [0013] of the current specification as follows:

[0013] For purposes of this discussion, the image forming details are not important to understanding the present invention. Rather, the focus properly is on the waste toner system 14 in terms of its operations vis-à-vis the waste toner being accumulated in the image forming apparatus 10. In selected embodiments, the discussion further focuses on the cooperative sharing of elements between the image forming system 12 and the waste toner system 14.

Please replace paragraph [0015] of the current specification as follows:

[0015] In operation, waste toner produced from ongoing imaging operations of the image forming apparatus 10 is conveyed to and collected in waste toner container 28. Thus, waste toner accumulates in container 28 and at some point container 28 must be removed and emptied or replaced. As this represents an ongoing point of service, it is desirable to accumulate as much waste toner as possible in container 28 before requiring its removal. In other words, it is desirable to fully use the volumetric capacity of container 28 for the collection of waste toner.

Please replace paragraph [0017] of the current specification as follows:

[0017] Even aided by the spreading operations of TDM 20, container 28 eventually reaches a “full” condition after which no additional waste toner should be collected in it. Indeed, one or more exemplary embodiments of the present invention prohibit additional image forming operations until the full condition, once detected, is relieved. Such prohibition avoids overfilling the waste container and reduces the

possibility of contaminating the interior of image forming apparatus 10 with waste toner overflow.

Please replace paragraph [0018] of the current specification as follows:

[0018] An exemplary embodiment of the waste toner system 14 detects the full condition of container 28 based on monitoring MCC 16 while motor 22 is driving the TDM 20. Waste toner system 14 also may detect a “near full” condition of container 28 to gain the valuable benefit of alerting users of image forming apparatus 10 that container 28 is nearing its capacity limit. Both conditions may be detected, for example, by monitoring one or more control signals of MCC 16 while it is controlling motor 22 during toner distributing operations. It should be noted that such monitoring may be based on analog or digital signals and that the present invention contemplates a variety of monitoring schemes.

Please replace paragraph [0019] of the current specification as follows:

[0019] Fig. 3 illustrates another exemplary waste toner system 14, wherein motor 22 comprises a shared motor used in image forming operations as well as in toner spreading operations. An exemplary drive apparatus 24 thus drives an image forming process member (IFPM) 32 and TDM 20, and includes a first drive apparatus 30 to drive IFPM 32, and further includes a selective engagement device (e.g., one-way clutch) 34 to selectively drive a second drive apparatus 36 that is coupled to TDM 20. Note that in some embodiments, IFPM 32 may function as an element of drive apparatus 30 such that clutch 34 is driven by the rotation of IFPM 32, for example. Fig. 3 further illustrates

an image processor 40, as a speed controller 42 and error circuit 44 within MCC 16, an encoder circuit 46, and one or more storage elements (e.g., memory device(s)) 48.

Please replace paragraph [0020] of the current specification as follows:

[0020] In exemplary operation, MCC 16 controls the direction and speed of motor 22 based on an output speed control signal generated by ~~it~~ the MCC 16. In an exemplary embodiment, speed controller 42 comprises a Pulse Width Modulation (PWM) controller that generates an output pair of PWM signals wherein, as is well understood in the art, the relative pulse polarities control the direction of motor 22 and the pulse widths control the speed of motor 22.

Please replace paragraph [0023] of the current specification as follows:

[0023] An exemplary drive circuit 26 may be implemented as an H-bridge motor drive circuit comprising a transistor-based push-pull arrangement that allows polarity reversal across motor 22 to enable operation in forward or reverse motor directions as desired. Those skilled in the art will appreciate that speed controller 42 may generate a speed control signal as a complementary pair of PWM waveforms to drive the H-bridge transistors. The natural impedance of motor 22, which may be a dc motor, acts as a low-pass filter to average the PWM pulses applied to drive circuit 26 such that the average drive voltage across the motor is a function of the modulated pulse width and frequency. The RS385-15155 dc motor manufactured by MABUCHI MOTOR AMERICA CORP., which maintains a business address of 3001 West Big Beaver Road, Suite 520, Troy, MI. 48084 U.S.A., represents an exemplary dc motor.

Please replace paragraph [0024] of the current specification as follows:

[0024] Such speed control complements the shared-motor drive arrangement. In the illustrated shared-motor embodiment, drive apparatus 24 drives both IFPM 32 and TDM 20 when motor 22 rotates in one direction, and drives only IFPM 32 when the motor 22 rotates in the other direction. To accomplish this, clutch 34 is configured to engage second drive apparatus 36 when the motor 22 drives the first drive apparatus 30 in one direction of rotation, and disengage second drive apparatus 36 when motor 22 drives it in the other direction.

Please replace paragraph [0025] of the current specification as follows:

[0025] For example, if IFPM 32 comprises a bump/alignment roller used in the image forming process to feed in and align media sheets prior to image formation, one rotational direction of motor 22 corresponds to a forward process direction and the other direction of motor 22 corresponds to a reverse process direction. Thus, clutch 34 of drive apparatus 24 may be configured disengage second drive apparatus 36 in the forward process direction and engage second drive apparatus 36 in the reverse process direction. In that embodiment, motor 22 is not loaded by TDM 20 during potentially sensitive bump/alignment operations associated with driving IFPM 32 in the forward process direction. Rather, TDM 20 is driven whenever motor 22 runs in the less sensitive reverse process direction. Of course, this drive logic may change depending on how motor 22 is shared with the image forming system 40 12.

Please replace paragraph [0027] of the current specification as follows:

[0027] Thus, in an exemplary embodiment, logic circuit 18 is programmed with, or has access to, one or more reference values, e.g., PWM value(s), corresponding to nominal waste toner accumulation conditions. In one embodiment, memory device(s) 48 store ~~stores~~ PWM reference values and may store other information, such as detection thresholds, etc. Reference values may be obtained, for example, by observing the speed control signal value needed to maintain a desired motor speed while driving TDM 20 with an empty container 28. By monitoring the PWM value(s) actually generated by MCC 16 while driving TDM 20, and comparing those monitored values to one or more reference values, logic circuit 18 may detect when (and to what extent) excess accumulated waste toner has begun interfering with the movement of TDM 20.

Please replace paragraph [0028] of the current specification as follows:

[0028] Logic circuit 18 may provide the desired speed information to MCC 16, or it may be provided by the ~~imaging~~ image processor 40. Indeed, because logic circuit 18 may be implemented using a microprocessor configured to execute coded program instructions, logic circuit 18 may be incorporated into imaging processor 40. Of course, it should be understood that logic circuit 18 may be implemented as discrete logic, or as a stand-alone microprocessor or other programmable device, etc., and that, in general, it may be implemented in hardware, software, or some combination thereof. Similarly, MCC 16 may be implemented in hardware, software, or some combination thereof, and

may be integrated with other function elements or implemented as a stand alone circuit, as needed or desired.

Please replace paragraph [0029] of the current specification as follows:

[0029] The inclusion of logic circuit 18 within ~~imaging~~ image processor 40, which may be referred to as a “Raster Imaging Processor” or RIP, is beneficial in that ~~imaging~~ image processor 40 already includes the necessary logic to interact with and monitor MCC 16 because of its need to control motor 22 during imaging operations involving the IFPM 32. For example, ~~imaging~~ image processor 40 may require that IFPM 32 be moved or rotated according to precise velocity profiles that ensure synchronization of IFPM 32 within the overall image forming process.

Please replace paragraph [0030] of the current specification as follows:

[0030] To better understand an exemplary embodiment of these detection operations, Fig. 4 provides a perspective view of selected details for image forming apparatus 10. An exemplary waste toner system 14 is configured to accumulate waste toner resulting from the imaging operations and includes motor 22 shared by the image forming and waste toner systems 12 and 14, respectively, waste toner container 28, toner distributing member 20, MCC 16, logic circuit 18, drive apparatus 24, and one or more waste toner transport members configured to receive waste toner from the image forming system 12 and transport the received waste toner to the waste toner container 28.

Please replace paragraph [0031] of the current specification as follows:

[0031] In the illustrated embodiment, the TDM 20 comprises a horizontally reciprocating toner rake 20 that is movably positioned at an upper elevation within container 28. A reciprocating arm ~~22~~ 21 couples rake 20 to a drive gear (not shown here), which forms a part of drive apparatus 24.

Please replace paragraph [0036] of the current specification as follows:

[0036] With 16-bit PWM control, for example, a digital control word may be varied from 0 (0% duty cycle) to 65,535 (100% duty cycle). A nominal driving value may be, for example, a midpoint value of 32,767. Therefore, by monitoring the differences between nominal and actual values and/or by monitoring changes in the actual values during toner spreading operations, the logic ~~control~~-circuit 18 can determine whether excess toner has accumulated within waste toner container 28. In other embodiments, logic circuit 18 may monitor some other speed control parameter used in the feedback control loop of MCC 16, and thus may simply receive one or more digital values generated by MCC 16 as part of its speed control operation. Regardless, logic circuit 18 can detect whether accumulated waste toner is interfering with rake movement by comparing the monitored values to the appropriate stored reference values.

Please replace paragraph [0039] of the current specification as follows:

[0039] Logic circuit 18 may detect a near full condition by comparing one or more speed control values generated during the forward stroke of rake 20 with one or more values generated during the return (reverse) stroke. (Note that logic circuit 18 may

average forward and reverse values over several raking cycles and compare averaged forward and reverse values.) If the speed control values corresponding to forward and reverse rake movements exhibit a characteristic difference, logic circuit 18 may infer that the waste toner container 28 is in a near full condition. The logic circuit 18 may generate a near full signal and communicate that signal to ~~imaging~~ image processor 40 (or to another processing system in image forming apparatus 10). In an exemplary embodiment, image forming apparatus 10 alerts users to the near full condition by displaying a message, light, emitting an audio alert, etc., which gives users a chance to empty the container 28 before it fills completely.

Please replace paragraph [0045] of the current specification as follows:

[0045] Fig. 5 illustrates the same end of IFPM 32 as shown in Fig. 4 but ~~provide~~ provides more details regarding an exemplary gear arrangement. IFPM 32 may be a media alignment roller, for example, that is used to feed media sheets into an image forming path (not shown) of the image forming system 12. As such, the roller is operated in a forward direction (relative to the feed direction of the media) to feed media sheets into the image forming system 12. When operating in the forward direction, it may be undesirable from a motor control perspective, to subject shared motor 22 to the additional (and potentially variable) load associated with driving the TDM 20.

Please replace paragraph [0046] of the current specification as follows:

[0046] Thus, one-way clutch 34 is configured to engage the first drive apparatus 30 with the second drive apparatus 36 when the motor 22 rotates in the reverse process

direction, where control of IFPM 32 is not critical to image formation timing, but not in the forward process direction. The forward and reverse directions of motor 22 thus should be understood as referring to the process-related operation of IFPM 32. Fig. 5 provides more detail.

Please replace paragraph [0047] of the current specification as follows:

[0047] In Fig. 5, one sees a drive pinion 70 attached at one end of IFPM 32—the motor 22 is coupled to the other end—and that pinion 70 engages a first gear 72 of clutch 34. Thus, rotation of IFPM 32 by motor 22 in either direction causes a counter rotation of gear 72. A second clutch gear 74 is positioned adjacent to and on the same rotational axis of gear 72. The interior faces of adjacent gears 72 and 74 are configured such that gear 72 engages gear 74 in one direction of rotation but not in the other. With this configuration, then, gear 74 drives gear 76 if the motor 22 rotates in one direction, but not when it rotates in the other direction. Gear 76 is coupled to rake drive arm ~~22~~ 21 shown in Fig. 4 and, thus, the TDM 20 is driven in one motor direction but not the other. Of course, those skilled in the art immediately will appreciate that other selective engagement drive arrangements may be used as needed or desired.

Please replace paragraph [0049] of the current specification as follows:

[0049] In operation, drive gear 76, which couples to TDM 20 via drive arm ~~22~~ 21, becomes locked by locking system 62 when container 28 is removed from the image forming apparatus 10. Logic circuit 18 and/or MCC 16 may be configured to include stall detection logic, wherein MCC 16 de-energizes motor 22 responsive to its detection

of the locked drive condition. The locked drive condition may be detected by, for example, observing a zero measured motor speed irrespective of the speed control signal output by MCC 16.

Please replace paragraph [0052] of the current specification as follows:

[0052] If motor 22 is not stalled, processing continues with logic circuit 18 monitoring MCC 16 to detect toner accumulation, as explained above (Step 106). If excess toner accumulation is detected (Step 108), waste toner system 14 provides an alert (e.g., full or near-full), which may be used to warn users and/or prohibit printing (Step 110). If excess toner accumulation is not detected, processing continues with determining whether continued toner distributing operations are desired (Step 112). If so, MCC 16 continues running motor 22 at the desired speed and monitoring/detection continues. Note that the detection operations need not run continuously and may be activated on a periodic basis keyed to time of operation and or the amount of printing activity.